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(54) **SYSTEMS AND METHODS FOR USE IN MANAGING DIGITAL IDENTITIES**

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See application file for complete search history.

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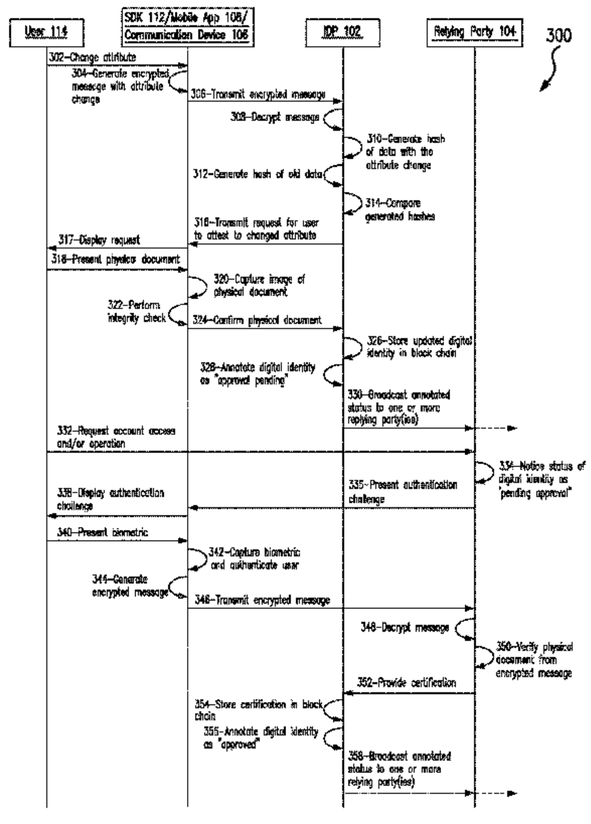
(57) **ABSTRACT**

Systems and methods are provided for managing digital identities associated with users. One exemplary method includes receiving, at a computing device, an encrypted message from a communication device associated with a user where the message includes a changed attribute for the user. The method also includes generating a first hash of a first digital identity for the user with the changed attribute and generating a second hash of a second digital identity of the user stored in a ledger data structure. And, in response to the first hash not matching the second hash, the method then includes broadcasting a pending status of the first digital identity to a relying party for the second digital identity, and storing a certification of the changed attribute, received from the relying party in response to the pending status, based on verification of the changed attribute by the relying party.

8 Claims, 3 Drawing Sheets



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H04L 9/08	(2006.01)
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(52) **U.S. Cl.**

CPC ***G06Q 20/4093*** (2013.01); ***H04L 9/0891*** (2013.01); ***H04L 9/321*** (2013.01); ***H04L 9/3231*** (2013.01); ***H04L 9/3239*** (2013.01); *H04L 9/50* (2022.05)

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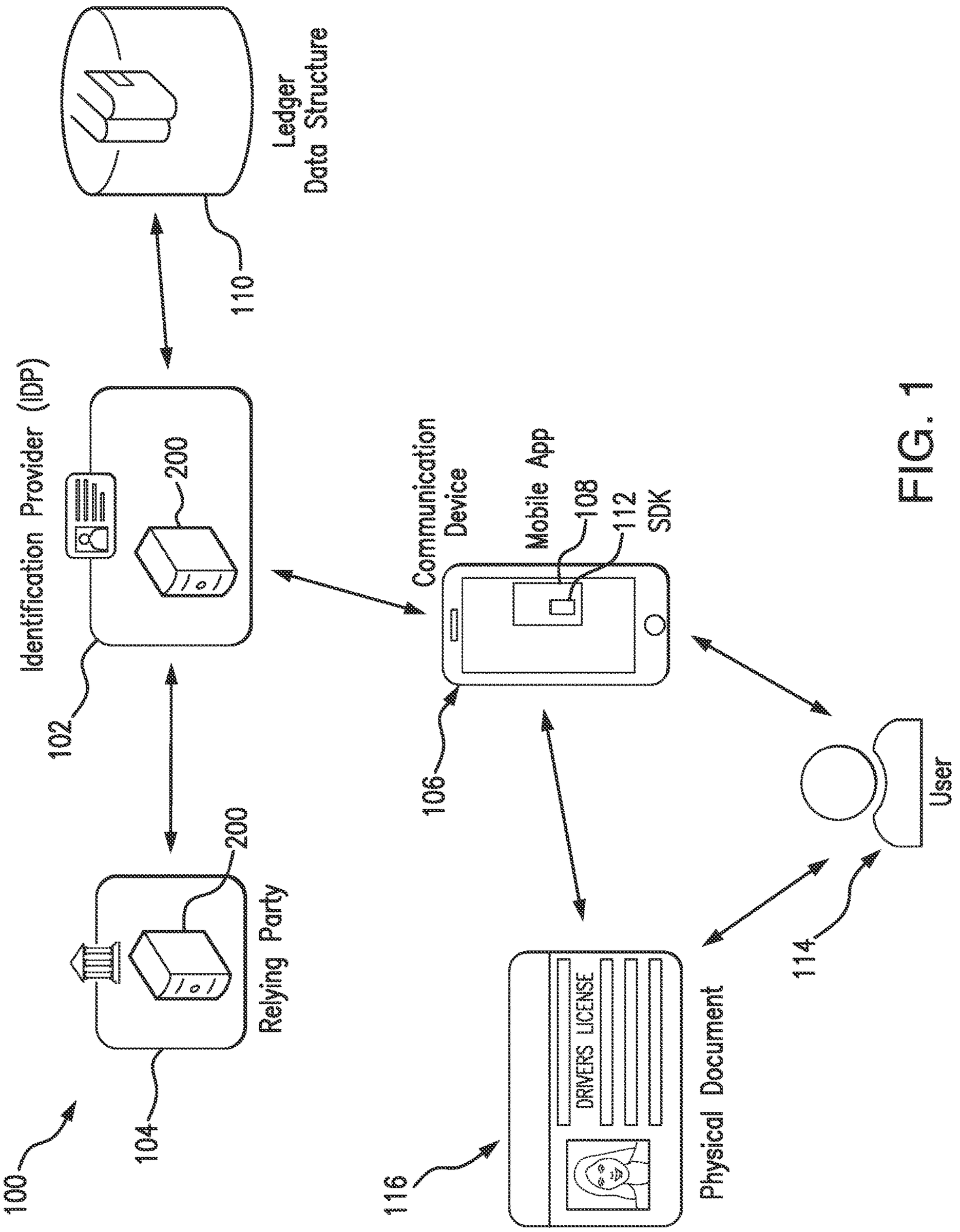
Ledger
Data Structure
110
Identification Provider (IDP)
200
102
200
Relying Party
104
100
Communication
Device
Mobile App
108
112
SDK
106
User
114
DRIVERS LICENSE
Physical Document
116

FIG. 1

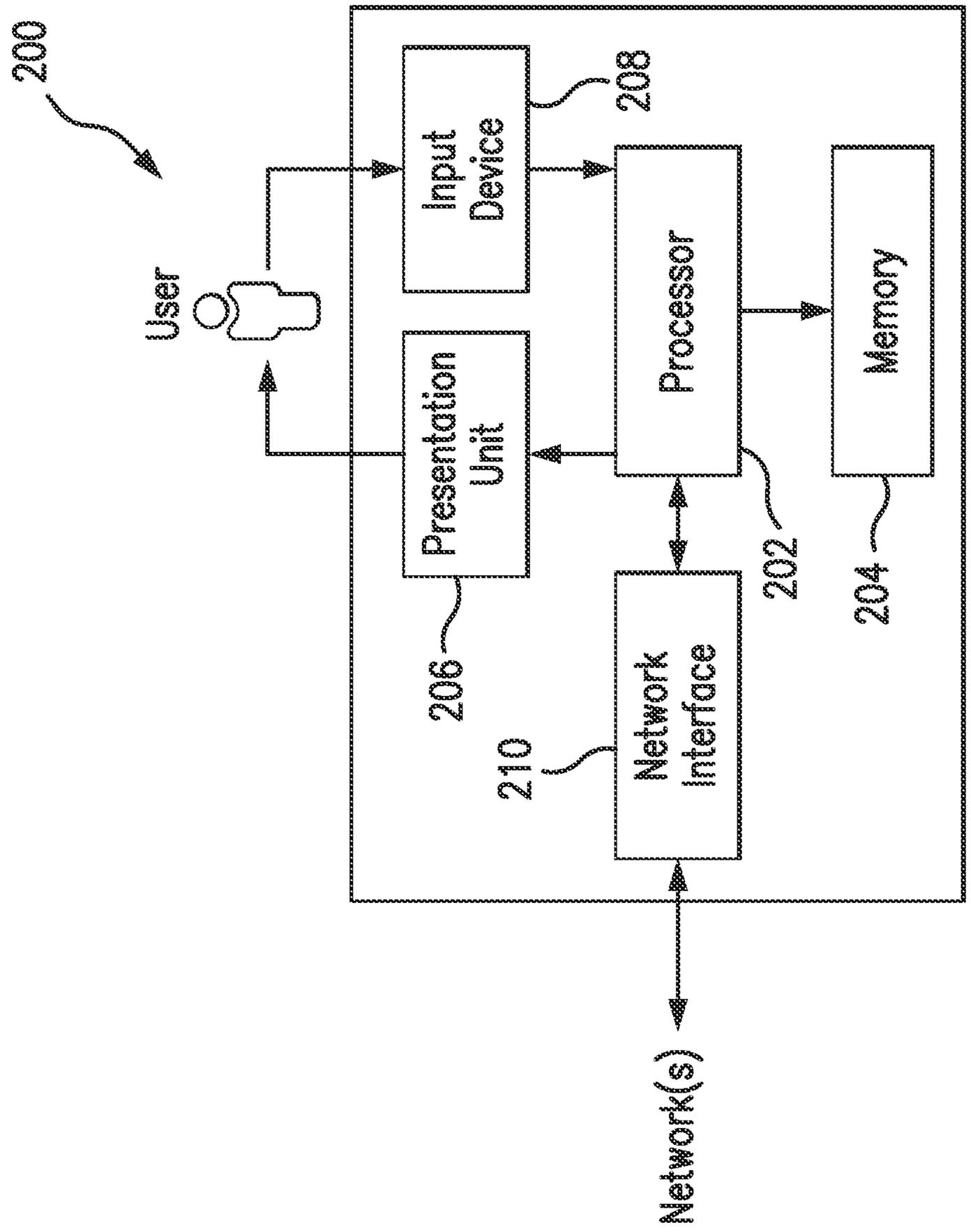
200
User
Input Device
208
Presentation Unit
Processor
Memory
206
202
204
210
Network Interface
Network(s)

FIG. 2

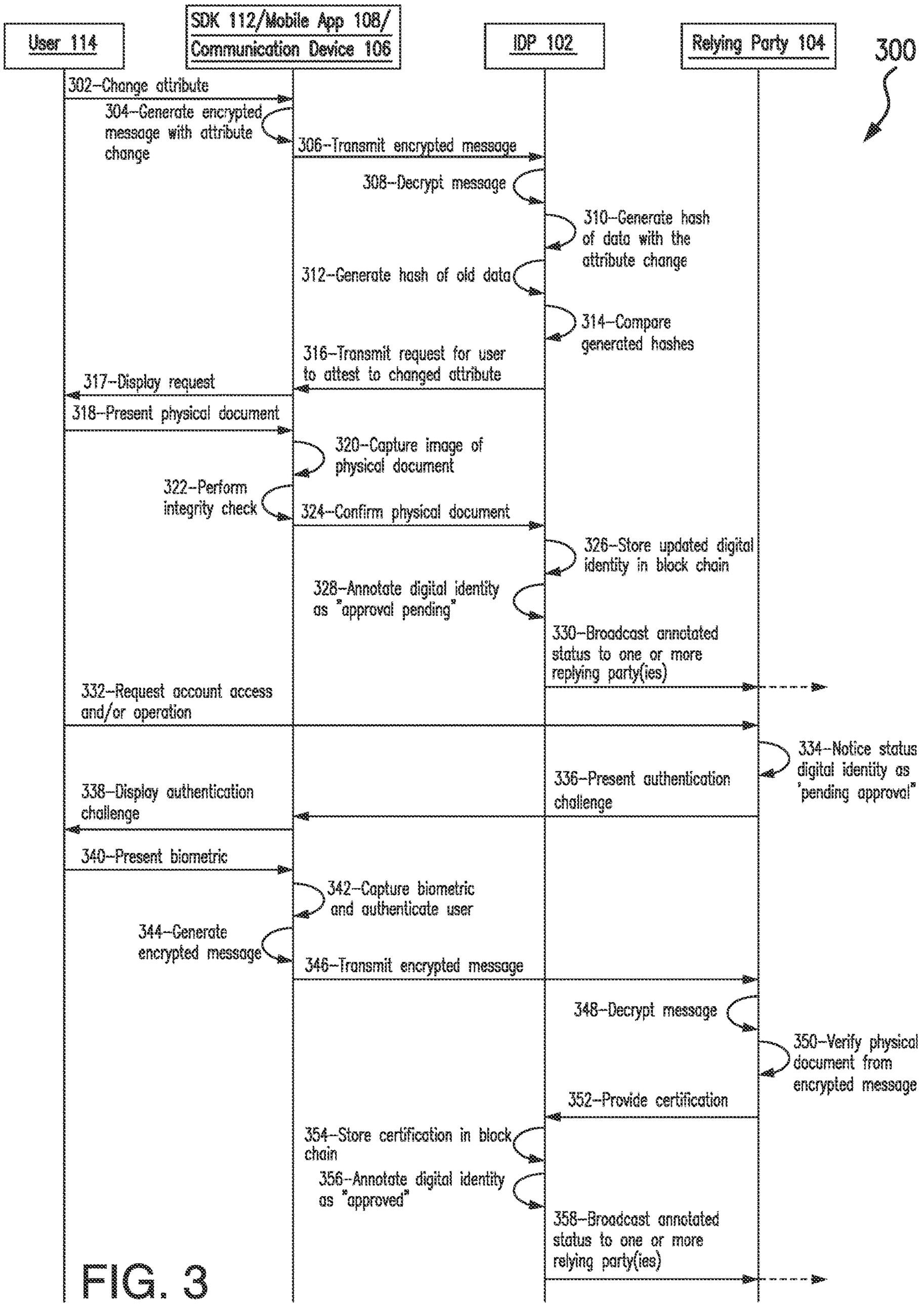
User 114
SDK 112/Mobile App 108/ Communication Device 106
IDP 102
Relying Party 104
300
302–Change attribute
304–Generate encrypted message with attribute change
306–Transmit encrypted message
308–Decrypt message
310–Generate hash of data with the attribute change
312–Generate hash of old data
314–Compare generated hashes
316–Transmit request for user to attest to changed attribute
317–Display request
318–Present physical document
320–Capture image of physical document
322–Perform integrity check
324–Confirm physical document
326–Store updated digital identity in block chain
328–Annotate digital identity as "approval pending"
330–Broadcast annotated status to one or more replying party(ies)
332–Request account access and/or operation
334–Notice status of digital identity as "pending approval"
336–Present authentication challenge
338–Display authentication challenge
340–Present biometric
342–Capture biometric and authenticate user
344–Generate encrypted message
346–Transmit encrypted message
348–Decrypt message
350–Verify physical document from encrypted message
352–Provide certification
354–Store certification in block chain
356–Annotate digital identity as "approved"
358–Broadcast annotated status to one or more relying party(ies)

FIG. 3

SYSTEMS AND METHODS FOR USE IN MANAGING DIGITAL IDENTITIES

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. patent application Ser. No. 15/891,062 filed on Feb. 7, 2018. The entire disclosure of the above application is incorporated herein by reference.

FIELD

The present disclosure is generally directed to systems and methods for use in managing digital identities, and in particular, to systems and methods for use in verifying changed attributes of digital identities prior to disseminating the digital identities to relying entities.

BACKGROUND

This section provides background information related to the present disclosure which is not necessarily prior art.

People are known to be associated with identities. The identities are often verified, by relying parties, through one or more physical documents, such as, for example, driver's licenses, government issued cards or documents (e.g., birth certificates, etc.), utility bills, etc. In addition, digital identities are known, which may include network or Internet equivalents to physical identities of people for identification in connections with network transactions. In connection therewith, when people apply for accounts, they are often required, by issuers of the accounts, to present proof of their identity, which may be provided through one or more such physical documents or via the digital identities. Thereafter, the account issuers or other parties rely on the identities (i.e., the relying parties), evidenced by the physical documents and/or the digital identities, to interact with the people and/or conduct business therewith.

DRAWINGS

The drawings described herein are for illustrative purposes only of selected embodiments and not all possible implementations, and are not intended to limit the scope of the present disclosure.

FIG. **1** is an exemplary system of the present disclosure suitable for use in managing digital identities for users;

FIG. **2** is a block diagram of a computing device that may be used in the exemplary system of FIG. **1**; and

FIG. **3** includes a flow diagram for an exemplary method, which may be implemented in connection with the system of FIG. **1** for verifying at least one attribute change for a user, for a digital identity associated with the user, prior to imposing the change, whereupon the updated digital identity may then be disseminated to relying parties.

Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.

DETAILED DESCRIPTION

Exemplary embodiments will now be described more fully with reference to the accompanying drawings. The description and specific examples included herein are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

Users often apply for accounts, such as, for example, banking accounts, investment accounts, payment accounts, etc., where the users are required to provide proof of their identities in connection with applying for the accounts. Once presented, and verified, the parties offering the accounts proceed to issue the accounts to the users, where the accounts then reflect certain attributes of the users' identities. Physical documents representing the users' identities as well as digital identities of the users may be relied upon for these purposes. With that said, from time to time, the attributes of the users' identities, such as, for example, mailing addresses, etc., may change.

Uniquely, the systems and methods herein permit attributes of digital identities of users to be changed, once verified by at least one relying party, whereby the digital identities and/or the changed attributes may then be disseminated to multiple other relying parties. In particular, for example, when an attribute of a user is changed, an application associated with a digital identity of the user and provided by an identification provider (e.g., an application including a software development kit (SDK) of an identification provider, etc.) transmits an encrypted message to the identification provider, where the message includes the changed attribute. The identification provider decrypts the message, and generates a hash of the digital identity with the changed attribute. In turn, the identification provider compares the hash to a hash of the digital identity for the user stored at the identification provider. If the hashes match, the user's digital identity is updated as requested. However, if the hashes do not match, the identification provider requests that the user attest to the changed attribute, via the application. When this is required, the user captures an image of a physical document representative of the identity of the user, whereupon an integrity of the image is verified by the application (or the identification provider). When verified, the changed attribute is added to the user's digital identity and stored in a data structure associated with the identification provider. The user's digital identity is further annotated as pending approval. An identification engine may then notify one or more relying parties of the annotation. In response, when the user attempts an interaction with a relying party to open an account, for example, the relying party may seek authentication of the user via the identification provider (and its corresponding application). The SDK then interacts with the relying party to permit the relying party to verify the changed attribute with the user based on the image of the physical document. The relying party then certifies to the identification provider that the changed attribute has been verified, whereupon the identification provider stores a certification in the data structure and annotates the digital identity as approved. The identification provider then notifies the one or more relying parties that the digital identity is approved. In this manner, improper and/or unauthorized changes to digital identities may be inhibited.

FIG. **1** illustrates an exemplary system **100**, in which one or more aspects of the present disclosure may be implemented. Although the system **100** is presented in one arrangement, other embodiments may include the parts of the system **100** (or other parts) arranged otherwise depending on, for example, relationships between users and identification providers, particular types of devices utilized with digital identities, relationships between users and relying parties, privacy requirements, etc.

The illustrated system **100** generally includes an identification provider (IDP) **102**, a relying party **104**, and a communication device **106** including a mobile application

108, each of which is coupled to (and is in communication with) one or more networks. The network(s) is/are indicated generally by arrowed lines in FIG. **1**, and may include one or more of, without limitation, a local area network (LAN), a wide area network (WAN) (e.g., the Internet, etc.), a mobile network, a virtual network, and/or another suitable public and/or private network capable of supporting communication among two or more of the parts illustrated in FIG. **1**, or any combination thereof.

The IDP **102** of the system **100** generally is associated with providing digital identities for users (e.g., for user **114**, etc.) to relying parties, including the relying party **104**, in connection with interactions by the users with the relying parties. In FIG. **1**, the IDP **102** is illustrated as a standalone service and/or device of the system **100**. However, the IDP **102** may additionally, or alternatively, be incorporated in whole or in part with another party in the system **100**, such as, for example, a payment network or a banking institution, etc. Specifically, for example, the IDP **102** may be incorporated into the MasterCard® payment network and configured to operate as described herein to provide corresponding services to users via and/or in association with the MasterCard® payment network. In addition, the IDP **102** is associated with a ledger data structure **110**. And, while shown as separate from the IDP **102** in FIG. **1**, the ledger data structure **110** may be integrated into the IDP **102** in one or more other embodiments.

The communication device **106** of the system **100** is generally associated with the user **114** and includes the mobile application **108**, which is configured (via executable instructions) to interact with the IDP **102** in connection with providing, requesting, updating, etc. a digital identity of the user **114** as described herein. Specifically, in this exemplary embodiment, the mobile application **108** includes a software development kit (SDK) **112** associated with the IDP **102**, which configures the communication device **106** to interact with the IDP **102**, as described herein. What's more, the communication device **106** is associated with the user **114** who, in turn, is associated with an identity. The identity of the user **114** may be evidenced by one or more physical documents, such as physical document **116** (shown as a license issued by a state, regional, or federal government). With that said, it should be appreciated that additional and/or other physical documents for the user **114** may be included in the system **100**, such as, for example, a passport, a government issued ID, a social security card, a health insurance card, a bank statement, an employee ID, a library card, a utility bill, etc. The physical document **116** (and other physical documents potentially included in the system **100**) then includes one or more attributes of the user **114** and/or of the identity of the user **114**, which distinguishes the user **114**, alone or in combination, from one or more other users. The attributes may include, without limitation, a name of the user **114**, a mailing address, a birthdate, contact information (e.g., a phone number, an email address, etc.), a social security number or other government identification number, or any other desired attribute of the user **114**, etc.

In general, the IDP **102** is configured to interact with the user **114** to receive evidence of the identity of the user **114**, when necessary, to compile a digital identity for the user. Once such evidence is received and once the user's identity is verified, the IDP **102** is configured to then compile the digital identity for the user **114** and to store the digital identity in the ledger data structure **110** associated with the IDP **102**. As such, the ledger data structure **110** includes the user's digital identity and other digital identities for other users, and corresponding certification records therefore (together or separately). In this exemplary embodiment, the ledger data structure **110** includes a block chain data structure, whereby the ledger data structure **110** includes a continually growing list of ordered records (where each record includes a time stamp and a reference or link to a prior record). That said, it should be understood that other, equivalent or not, data structures may be employed in other embodiments for use with the IDP **102** and/or the ledger data structure **110**, etc.

Thereafter, the IDP **102** is configured to provision the compiled digital identity for the user **114** to one or more communication devices as appropriate, such as, for example, the communication device **106**. The digital identity may then be provided, by the user **114** (via the communication device **106**, etc.), to one or more relying parties, such as the relying party **104**, when requested and/or in connection with an application for an account by the user **114** at the relying party **104**, or otherwise. In connection therewith, the relying party **104** is able to and does rely on the digital identity of the user **114** (and digital identities associated with other users) to satisfy, for example, proof of identity and/or know your customer (KYC) requirements, etc. (e.g., when the relying party **104** includes a financial institution that issues account to users, etc.).

FIG. **2** illustrates an exemplary computing device **200** that can be used in the system **100** of FIG. **1**. The computing device **200** may include, for example, one or more servers, workstations, personal computers, laptops, tablets, smartphones, etc. In addition, the computing device **200** may include a single computing device, or it may include multiple computing devices located in close proximity or distributed over a geographic region, so long as the computing devices are specifically configured to function as described herein. In the exemplary embodiment of FIG. **1**, each of the IDP **102** and the relying party **104** is illustrated as including, or being implemented in, computing device **200**, coupled to (and in communication with) one or more networks. In addition, each of the communication device **106** associated with the user **114** and the ledger data structure **110** can be considered a computing device generally consistent with computing device **200** for purposes of the description herein. However, the system **100** should not be considered to be limited to the computing device **200**, as described below, as different computing devices and/or arrangements of computing devices may be used in other embodiments. In addition, different components and/or arrangements of components may be used in other computing devices.

Referring to FIG. **2**, the exemplary computing device **200** includes a processor **202** and a memory **204** coupled to (and in communication with) the processor **202**. The processor **202** may include one or more processing units (e.g., in a multi-core configuration, etc.). For example, the processor **202** may include, without limitation, a central processing unit (CPU), a microcontroller, a reduced instruction set computer (RISC) processor, an application specific integrated circuit (ASIC), a programmable logic device (PLD), a gate array, and/or any other circuit or processor capable of the functions described herein.

The memory **204**, as described herein, is one or more devices that permit data, instructions, etc., to be stored therein and retrieved therefrom. The memory **204** may include one or more computer-readable storage media, such as, without limitation, dynamic random access memory (DRAM), static random access memory (SRAM), read only memory (ROM), erasable programmable read only memory (EPROM), solid state devices, flash drives, CD-ROMs, thumb drives, floppy disks, tapes, hard disks, and/or any

other type of volatile or nonvolatile physical or tangible computer-readable media. The memory **204** may be configured to store, without limitation, identity attributes, digital identities, certificates, ID data, document images, and/or other types of data (and/or data structures) suitable for use as described herein. Furthermore, in various embodiments, computer-executable instructions may be stored in the memory **204** for execution by the processor **202** to cause the processor **202** to perform one or more of the functions described herein, such that the memory **204** is a physical, tangible, and non-transitory computer readable storage media. Such instructions often improve the efficiencies and/or performance of the processor **202** and/or other computer system components configured to perform one or more of the various operations herein. It should be appreciated that the memory **204** may include a variety of different memories, each implemented in one or more of the functions or processes described herein.

In the exemplary embodiment, the computing device **200** also includes a presentation unit **206** that is coupled to (and is in communication with) the processor **202** (however, it should be appreciated that the computing device **200** could include output devices other than the presentation unit **206**, etc.). The presentation unit **206** outputs information (e.g., prompts to present a document showing a changed attribute, etc.), visually or audibly, for example, to a user of the computing device **200** (e.g., user **114** associated with the communication device **106**, etc.), etc. And various interfaces (e.g., as defined by the mobile application **108**, or as defined by one or more websites, etc.) (e.g., including instructions to scan a particular document, etc.) may be displayed at computing device **200**, and in particular at presentation unit **206**, to display certain information in connection therewith. The presentation unit **206** may include, without limitation, a liquid crystal display (LCD), a light-emitting diode (LED) display, an organic LED (OLED) display, an "electronic ink" display, speakers, etc. In some embodiments, the presentation unit **206** may include multiple devices.

In addition, the computing device **200** includes an input device **208** that receives inputs from the user (i.e., user inputs) of the computing device **200** such as, for example, images of documents, etc., in response to prompts from the mobile application **108** (and/or the SDK **112**), as further described below. The input device **208** may include a single input device or multiple input devices. The input device **208** is coupled to (and is in communication with) the processor **202** and may include, for example, one or more of a keyboard, a pointing device, a mouse, a stylus, a camera, a touch sensitive panel (e.g., a touch pad or a touch screen, etc.), another computing device, and/or an audio input device. In various exemplary embodiments, a touch screen, such as that included in a tablet, a smartphone, or similar device, may behave as both the presentation unit **206** and an input device **208**.

Further, the illustrated computing device **200** also includes a network interface **210** coupled to (and in communication with) the processor **202** and the memory **204**. The network interface **210** may include, without limitation, a wired network adapter, a wireless network adapter (e.g., an NFC adapter, a Bluetooth™ adapter, etc.), a mobile network adapter, or other device capable of communicating to one or more different ones of the networks herein and/or with other devices described herein. In some exemplary embodiments, the computing device **200** may include the processor **202** and one or more network interfaces incorporated into or with the processor **202**.

Referring again to FIG. **1**, in response to a request to change an attribute of the user's identity, the user **114** provides the changed attribute to the mobile application **108** at the communication device **106**. In response, the communication device **106**, as configured by the SDK **112**, notifies the IDP **102** of the changed attribute and generates an encrypted message, which includes the digital identity attributes for the user **114** held by the communication device **106** (in whole or in part) along with the changed attribute. The communication device **106** is configured, by the SDK **112**, to then transmit the encrypted message to the IDP **102**, via one or more networks.

In response, the IDP **102** is configured to generate a hash of all the data received from the communication device **106**, and to decrypt the message and retrieve a digital identity record for the user **114** from the ledger data structure **110**. The digital identity record either includes a hash for the digital identity, or the IDP **102** is configured to generate a hash for the digital identity record from the ledger data structure **110**. In either case, the IDP **102** is configured to compare the hash from the ledger data structure **110** and the hash for the received message. Because there is a changed attribute, in this example, the hashes will not match. As such, in response to the encrypted message, the IDP **102** is configured to transmit a request to the mobile application **108** for the user **114** to attest to the changed attribute.

The user **114**, via the communication device **106**, receives the request and presents the physical document **116** to the communication device **106**. The communication device **106**, as configured by the mobile application **108** and/or the SDK **112**, captures an image of the physical document **116** (e.g., via a camera input device **208** of the communication device **106**, etc.) and checks the integrity of the image (e.g., to determine (or estimate) whether the image and/or the physical document is genuine, false, and/or fake, etc.). The image may then be stored in memory (e.g., memory **204**, etc.) of the communication device **106**. If the image is not determined (or estimated) to be false/fake, the communication device **106**, as configured by the SDK **112**, confirms the integrity of the image to the IDP **102**. In turn, based on the confirmation, the IDP **102** is configured to write an updated digital identity record for the user **114** to the ledger data structure **110**, in the block chain thereof. The updated digital identity record includes the new attribute for the user **114** and a reference back to the original digital identity record for the user **114**. Additionally, the IDP **102** is configured to annotate the updated digital identity record with a status of "pending approval" or other suitable status to indicate that the change is pending and then to broadcast the annotation to relying parties for the digital identity of the user **114** (e.g., to all relying parties that have previously requested the digital identity of the user **114**, to all relying parties associated with the IDP **102**, etc.). In some exemplary embodiments, the ledger data structure **110** may include a listing of relying parties associated with the user **114** and/or the user's digital identity (e.g., based on prior interactions between the user **114** and the relying parties, based on input and/or selection of the relying parties by the user **114**, etc.). And, in connection therewith, the IDP **102** may be configured to broadcast the annotation for the user's digital identity to the particular relying parties included in the ledger data structure **110** as associated with the user **114** and/or the user's digital identity (e.g., only to those relying parties, etc.).

Subsequently, when the user **114** attempts to access a network-based application (e.g., a website, etc.) associated with the relying party **104** (e.g., as part of accessing an existing account with the relying party **104**, etc.), the relying

party **104** is configured to identify the annotation of the digital identity and to challenge the user to complete a biometric authentication (or other authentication), via the communication device **106** and, specifically, the mobile application **108**. When the biometric authentication is completed (and with the user **114** authenticated), the communication device **106**, as configured by the SDK **112**, generates an encrypted message, which includes the physical document **116** (specifically, the image associated therewith) associated with the user **114** (as previously captured by the communication device **106**), and transmits the same to the relying party **104**. The relying party **104**, in turn, verifies the physical document **116** in one or more manners. For example, in the current description the physical document **116** includes a license issued by a state, regional, or federal government. As such, the relying party **104** may interact with the issuing government (or with a verification service that then interacts with the issuing government, etc.) to verify the physical document **116**. Alternatively, the relying party **104** may interact with the IDP **102** whereby the IDP **102** (as a service) verifies the physical document **116** and/or communicates with a third party verification provider that then, in turn, interacts with an issuing authority for the physical document **116** to verity the document **116** (e.g., regardless of a type of the physical document **116**, etc.). In any case, when verified, the relying party **104** is configured to compile and transmit a certification for the updated digital identity of the user **114** to the IDP **102**, which is configured to record the certification to the ledger data structure **110**. Thereafter, the IDP **102** is configured to annotate the updated digital identity with a status of "approved" or other suitable status indicative of the above process, and to broadcast the annotation to the relying party **104** (and potentially other relying parties associated with the user **114** and/or the user's digital identity in the ledger data structure **110**) for the digital identity of the user **114**. This informs the relying party **104** of the change to the user's digital identity and the certification to the change, such that the relying party **104** is able to also rely on the new/updated digital identity, including the changed attribute.

FIG. **3** illustrates an exemplary method **300** for use in verifying at least one attribute change of a user, for a digital identity associated with the user, prior to imposing the change, whereupon the user's digital identity with the change may then be disseminated to relying parties. The exemplary method **300** is described as implemented in the IDP **102**, the relying party **104**, the communication device **106**, and the ledger data structure **110** of the system **100**. Reference is also made to the computing device **200**. However, the methods herein should not be understood to be limited to the system **100** or the computing device **200**, as the methods may be implemented in other systems and/or computing devices. Likewise, the systems and the computing devices herein should not be understood to be limited to the exemplary method **300**.

In the method **300**, the user **114** is associated with an exemplary digital identity that includes, for example, a name (e.g., John Smith), a mailing address (e.g., 123 Main Street in Purchase, New York), a birthdate (e.g., Jan. 1, 2001), a government ID (e.g., 123-45-6789), an email address (e.g., jsmith@email.com) and a phone number (e.g., 123-456-7890). This identity of the user **114** is represented in Table 1 below. A digital identity including the attributes of the user **114** shown in Table 1 is also included in the ledger data structure **110**, as well as (potentially) at the user's communication device. It should be appreciated that digital identities may include more, less, or different attributes of users in other embodiments.

TABLE 1

Attribute	Value
Name	John Smith
Mailing Address	123 Main Street Purchase, New York
Birthdate	Jan. 1, 2001
Government ID	123-45-6789
Email Address	jsmith@email.com
Phone Number	123-456-7890

As occurs from time to time, the user **114**, in this example, moves from one residence to another, whereby the mailing address of the user is changed. As such, the digital identity for the user **114** stored in the block chain of the ledger data structure **110** is no longer accurate. To update the digital identity maintained and provided by the IDP **102**, the user **114** accesses the mobile application **108**, at the communication device **106**, and changes, at **302** in the method **300**, the mailing address attribute of his/her identity from "123 Main Street in Purchase, New York," to "456 Main Street in Winghaven, Missouri" In this example, no other attributes of the user's identity are changed.

In response, the SDK **112** of the communication device **106** generates, at **304**, an encrypted message, which includes the digital identity of the user **114** (i.e., the data included in Table 1) as stored at the communication device **106** and also the new mailing address for the user **114**. The data is encrypted using a public key (e.g., associated with the IDP **102** as a provider of the SDK **112**, associated with the relying party **104**, etc.) and signed using a private key associated with the user **114** (e.g., associated with the user's communication device **106**, the mobile application **108**, the SDK **112**, etc.). Thereafter, the SDK **112**, and broadly, the communication device **106**, transmits, at **306**, the encrypted message to the IDP **102**. The IDP **102** receives the encrypted messages and, initially, decrypts the message, at **308**, using its private key. Once the message is decrypted, the IDP **102** generates, at **310**, a hash of the data received from the SDK **112** in the message, including, for example, a hash of the data shown in Table 1, and a hash of the updated address data for the user. In addition, the IDP **102** retrieves a digital identity record for the user **114** in the ledger data structure **110** and generates, at **312**, a hash of the data of the retrieved digital identity (i.e., the name, mailing address, birthdate, government ID, email address, and phone number generally corresponding to the data received from the user **114**). It should be appreciated that any suitable hash function may be used herein, including, for example, the MD5 hash function, the SHA-1 hash function, the SHA-2 hash function, the SHA-256 hash function, etc., or one or more other functions suitable and/or conventional to provide a digital signature of the data subjected to the given functions, etc. With that said, an example of a SHA-256 hash for identity data of a user, including a name of the user and a date-of-birth of the user, is provided in Table 2.

TABLE 2

SHA-256 Hash
382FD9ED10996833DA7AA9664A96C56E7CF83683D440E338129C68EF61716945

Then, at **314**, the IDP **102** compares the hashes and, here, given the change in the mailing address for the user **114**, the IDP **102** finds no match by the comparison. As such, in this example, the IDP **102** transmits a request for the user **114** to attest to the changed attribute, at **316**. In turn, the request is displayed to the user **114**, by the communication device **106**, at **317**, and the communication device **106** solicits the user **114** to present a physical document evidencing the changed attribute (e.g., document **116**, etc.). At **318**, the user **114** presents the physical document **116** (and provides a user input to the input device **208** of the communication device **106**, indicating the same), whereupon the communication device **106** captures an image of the physical document **116**, at **320**. In connection therewith, the communication device **106** and/or the SDK **112** performs an integrity check, at **322**, of the captured image of the document **116**, to confirm that the image is of a genuine physical document and/or to determine if the image and/or the physical document **116** is fake and/or false. In particular, for example, the SDK **112** may determine the integrity of the image based on the ICAO 9303 standard (e.g., to determine or define whether the captured image of the physical document **116** and/or the physical document **116** itself is a good machine readable document or not, etc.) or based on one or more other suitable standards, as is conventional. In connection therewith, the SDK **112** may further perform one or more quality checks on the image to initially ensure the integrity and/or validation of the image may be performed based on one or more suitable standards known to those skilled in the art. When the integrity of the captured image is confirmed and/or not challenged, the SDK **112**, via the communication device **106**, confirms the physical document **116** to the IDP **102**, at **324**. In addition, the communication device **106** may store the captured image of the physical document **116** in memory thereof (e.g., memory **204**, etc.). What's more, the SDK **112** may verify the changed attribute in the physical document **116** (e.g., verify that the physical document **116** includes the changed attribute, etc.) and convey such verification to the IDP **102** (e.g., as part of confirming the physical document to eth IDP **102** at **324**, etc.) and/or convey such verification to the relying party **104** (as appropriate).

In turn in the method **300**, the IDP **102** stores an updated digital identity, or part thereof, in the block chain in the ledger data structure **110**, at **326**, and annotates the digital identity with "pending approval" or other suitable status, at **328**. The IDP **102** then broadcasts, at **330**, the status of the digital identity to one or more relying parties, including the relying party **104** (and other relying parties as indicated by the dotted line). The broadcast status may simply include a flag for the user's digital identity, or it may include the entire digital identity for the user **114** including the changed attribute. And, as described above in the system **100**, the relying parties to which the status of the user's digital identity is broadcast may include relying parties indicated in the ledger data structure **110** as being associated with the user **114** and/or the user's digital identity, and/or it may include one or more other desired relying parties.

Subsequently in the method **300**, when the user requests, at **332**, account access (e.g., to view his/her account balance, etc.) and/or other operation (e.g., a balance transfer, a payment, etc.) from the relying party **104**, or requests other interactions with the relying party **104**, the relying party **104** recognizes or notices, at **334**, the status of the digital identity of the user as "pending approval" and presents an authentication challenge to the user **114**, via the communication device **106**, at **336**. In turn, the communication device **106** displays the authentication challenge to the user **114**, at **338**, at presentation unit **206** of the communication device **106**. In response, the user **114** presents, for example, a biometric, at **340** (or other requested response to the challenge). The communication device **106** captures the biometric and authenticates the user, at **342** (e.g., compares the captured response to a reference response stored at the communication device **106**, etc.). When authenticated, the communication device **106**, and specifically the SDK **112**, generates an encrypted message, at **344**, using the public key of the relying party **104** (and signed using the private key associated with the user **114** (e.g., associated with the user's communication device **106**, the mobile application **108**, the SDK **112**, etc.)) confirming the authentication of the user **114** and including the image of the physical document **116** (as previously captured by the communication device **106**, at **320**). In turn, the communication device **106**, and specifically the SDK **112**, transmits the encrypted message to the relying party **104**, at **346**.

Upon receipt, the relying party **104** decrypts the message, at **348**, using its private key and then verifies the image of the physical document **116** (as included in the encrypted message), at **350**. Once the image/physical document **116** is verified, the relying party **104** provides a certification to the IDP **102**, at **352**, therefore. In response, IDP **102** signs the changed attribute for the user **114** in connection with the user's digital identity and encrypts the data to indicate that it certifies the user's data. The IDP **102** then stores the certification received from the relying party **104** in connection with the digital identity, at **354**, in the block chain in the ledger data structure **110** (and, in some embodiments, the received image of the physical document **116**). In addition, the IDP **102** annotates the updated digital identity with "approved" or other suitable status, at **356**. And, finally, the IDP **102** broadcasts, at **358**, the approved status of the digital identity to the relying party **104** (and other relying parties as indicated by the dotted line).

Again and as previously described, it should be appreciated that the functions described herein, in some embodiments, may be described in computer executable instructions stored on a computer readable media, and executable by one or more processors. The computer readable media is a non-transitory computer readable storage medium. By way of example, and not limitation, such computer-readable media can include RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium that can be used to carry or store desired program code in the form of instructions or data structures and that can be accessed by a computer. Combinations of the above should also be included within the scope of computer-readable media.

It should also be appreciated that one or more aspects of the present disclosure transform a general-purpose comput-

ing device into a special-purpose computing device when configured to perform the functions, methods, and/or processes described herein.

As will be appreciated based on the foregoing specification, the above-described embodiments of the disclosure may be implemented using computer programming or engineering techniques including computer software, firmware, hardware or any combination or subset thereof, wherein the technical effect may be achieved by performing at least one of the following operations: (a) receiving, at a computing device, an encrypted message from a communication device associated with a user, the encrypted messaging including at least one changed attribute for the user; (b) generating a hash of a digital identity for the user with the at least one changed attribute; (c) generating, by the computing device, a hash of the digital identity of the user stored in a ledger data structure; (d) transmitting a request for the user to attest to the at least one changed attribute when the generated hashes do not match; (e) broadcasting a pending status of the digital identity of the user to a relying party for the digital identity; (f) storing a certification of the at least one changed attribute, received from the relying party in response to the pending status, based on verification of the at least one changed attribute by the relying party, thereby adopting the relying party verification of the at least one changed attribute; (g) receiving, from the communication device associated with the user, in response to the request for the user to attest to the at least one changed attribute, a confirmation of integrity of a physical document for the user as captured at the communication device; (h) annotating the digital identity with the pending status based on the confirmation of the physical document; (i) receiving the certification of the at least one changed attribute from the relying party; (j) annotating the digital identity with an approved status based on the certification from the relying party; and (k) broadcasting the approved status of the digital identity of the user to the relying party and/or at least one additional relying party.

Exemplary embodiments are provided so that this disclosure will be thorough, and will fully convey the scope to those who are skilled in the art. Numerous specific details are set forth such as examples of specific components, devices, and methods, to provide a thorough understanding of embodiments of the present disclosure. It will be apparent to those skilled in the art that specific details need not be employed, that example embodiments may be embodied in many different forms and that neither should be construed to limit the scope of the disclosure. In some example embodiments, well-known processes, well-known device structures, and well-known technologies are not described in detail.

The terminology used herein is for the purpose of describing particular exemplary embodiments only and is not intended to be limiting. As used herein, the singular forms "a," "an," and "the" may be intended to include the plural forms as well, unless the context clearly indicates otherwise. The terms "comprises," "comprising," "including," and "having," are inclusive and therefore specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. The method steps, processes, and operations described herein are not to be construed as necessarily requiring their performance in the particular order discussed or illustrated, unless specifically identified as an order of performance. It is also to be understood that additional or alternative steps may be employed.

When a feature is referred to as being "on," "engaged to," "connected to," "coupled to," "associated with," "included with," or "in communication with" another feature, it may be directly on, engaged, connected, coupled, associated, included, or in communication to or with the other feature, or intervening features may be present. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

Although the terms first, second, third, etc. may be used herein to describe various features, these features should not be limited by these terms. These terms may be only used to distinguish one feature from another. Terms such as "first," "second," and other numerical terms when used herein do not imply a sequence or order unless clearly indicated by the context. Thus, a first feature discussed herein could be termed a second feature without departing from the teachings of the example embodiments.

None of the elements recited in the claims are intended to be a means-plus-function element within the meaning of 35 U.S.C. § 112(f) unless an element is expressly recited using the phrase "means for," or in the case of a method claim using the phrases "operation for" or "step for."

The foregoing description of exemplary embodiments has been provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

What is claimed is:

1. A computer-implemented method for use in managing a digital identity for a user, the method comprising:

generating and transmitting, by a communication device associated with a user to a computing device, an encrypted message including at least one changed attribute for the user;

receiving, at the computing device, the encrypted message from the communication device associated with the user;

generating a first hash of a first digital identity for the user, the first digital identity including the at least one changed attribute;

generating, by the computing device, a second hash of a second digital identity of the user, the second digital identity included in a ledger data structure and excluding the at least one changed attribute;

determining, by the computing device, that the first and second hashes do not match;

transmitting, by the computing device, a request for the user to attest to the at least one changed attribute in response to the first and second hashes not matching;

displaying, by the communication device, the request for the user to attest to the at least one changed attribute;

capturing, by the communication device, an image of a physical document presented to the communication device, in response to the request;

confirming, by the communication device, the physical document based on the image of the physical document;

transmitting, by the communication device, a confirmation of the changed attribute to the computing device in response to confirming the physical document based on the image of the physical document;

annotating, by the computing device, the first digital identity with a pending status based on the confirmation of the at least one changed attribute;

broadcasting the pending status of the first digital identity to a relying party for the second digital identity;

receiving, by the computing device, from the relying party, a certification for the at least one changed attribute in response to broadcasting the pending status, the certification indicative of the at least one changed attribute being verified by the relying party;

storing the certification of the at least one changed attribute, wherein the stored certification is indicative of verification by the relying party of the at least one changed attribute;

annotating the first digital identity with an approved status based on the certification from the relying party; and

broadcasting the approved status of the first digital identity to the relying party and/or at least one additional relying party associated with the second digital identity.

2. The computer-implemented method of claim **1**, further comprising storing the first digital identity in the ledger data structure, prior to annotating the first digital identity with the pending status.

3. The computer-implemented method of claim **1**, wherein the first digital identity includes data included in the second digital identity and the at least one changed attribute from the communication device in the encrypted message.

4. The computer-implemented method of claim **1**, wherein the relying party includes at least one banking institution; and

wherein the computing device is included in a payment network.

5. A system for use in managing a digital identity for a user, the system comprising:

a computing device comprising:

a memory comprising digital identities for multiple users; and

a processor in communication with the memory, the processor configured to:

receive an encrypted message, the encrypted message including a first digital identity of a user, the first digital identity including at least one changed attribute for the user;

generate a first hash of the first digital identity of the user;

retrieve a second digital identity of the user from the memory and generate a second hash of the second digital identity;

compare the first hash and the second hash;

determine that the first and second hashes do not match;

transmit a request for the user to attest to the at least one changed attribute in response to the first and second hashes not matching;

annotate the first digital identity with a pending approval status based on a received confirmation of the at least one changed attribute;

broadcast the pending approval status of the first digital identity of the user to a relying party associated with the second digital identity in the memory;

receive, from the relying party, a certification for the at least one changed attribute, the certification indicative of the at least one changed attribute being verified by the relying party;

store the certification in the memory in association with the first digital identity, wherein the certification is indicative of adopting the relying party verification of the at least one changed attribute;

annotate the status of the first digital identity stored in the memory with an approved status based on the certification from the relying party; and

broadcast the approved status of the first digital identity of the user to the relying party and/or at least one additional relying party associated with the second digital identity; and

a communication device comprising a second memory, and a second processor in communication with the second memory, the second processor configured to:

generate and transmit the encrypted message to the computing device;

display the request for the user to attest to the at least one changed attribute;

capture an image of a physical document presented to the communication device, in response to the request;

confirm the physical document based on the image of the physical document; and

transmit the confirmation of the changed attribute to the computing device in response to confirming the physical document based on the image of the physical document.

6. The system of claim **5**, wherein the processor is further configured to identify the relying party in the memory as associated with the second digital identity, prior to broadcasting the pending approval status of the first digital identity to the relying party.

7. The system of claim **5**, wherein the processor is configured, in connection with generating the first hash of the first digital identity, to generate said first hash based on the second digital identity retrieved from the memory and the at least one changed attribute included in the encrypted message.

8. The system of claim **5**, further comprising a payment network, the payment network including the processor.

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